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SUBJECT: Quarterly Progress Report: Landsat-4 Proposal A-25
"Evaluation of Landsat-4 TM and MSS Ground Geometry Performance Without Ground Control"

General Status of Work

The techniques developed to characterize the band to band and swath to swath registration of Landsat-4 TM and MSS imagery have been applied to two Harrisburg, Pennsylvania scenes, an Imperial Valley, California scene, and the November 2, 1982 Washington DC scene. Two scenes of the Sacramento, California area have been ordered in anticipation of the inability to acquire a second Imperial Valley, California scene. Digitial elevation files for the Pennsylvania and California scene regions have been obtained and registered to the images for subsequent study of the effect of relief displacement on scene to scene misregistration. A complete ground control point library has been established for the Harrisburg scene (240 points) and Imperial Valley scene (150 points). The variance of those sets of points from both a linear and quadratic surface fit has been made. The Space Oblique Mercator projection software has been obtained from the USGS, and will be applied to the gaps to determine the overall TM projection geometry goodness of fit to ground control.

Open Problems

Awaiting the delivery of a second TM scene, August 14, 1982, acquired via TDRSS, for the Sacramento, California scene. It is expected that this scene will be provided in the near future by the TIPS processor.

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Solved Problems

Two sets of TM and MSS data are now available for a complete comparative study. No further data will be required by this project.

Results of Data

All analyses of band to band and line to line registration show very good results similar to those found by other researchers (including the primary and secondary focal plane misregistration). Comparison between the November 2, 1982, Harrisburg scene lost 200 lines and the November 2, 1982, Washington DC scene first 200 lines showed misregistration associated with SOM projection assumptions. Scene to scene misregistration for Harrisburg, Pennsylvania appears to be systematically related to both topographic offset and SOM projection assumptions related to their different radar tracks. Finally, a comparison of the gaps to a quadratic surface fit appears to indicate the mirror scan velocity profile deviates from the nominal derived from the pre-flight tests. A check with the SOM projected gaps should confirm or deny this preliminary finding.

Planned Research: First Quarter FY-84

A systematic analysis of scene to scene and SOM projection registration deviations will be completed and a paper prepared for the formal ASP meeting, March, 1984. Copies of the submitted abstract are enclosed.

Publications

R. E. Walker, A. L. Zobrist, N. A. Bryant, B. Gokhman, S. Z. Friedman, and T. Logan, "An Analysis of Landsat-4 Thematic Mapper Geometric Properties." Abstract prepared for ASP Meeting, March 1984. Washington DC.

Data Provided by GSFC

Imagery acknowledged in previous quarterly reports.

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AN ANALYSIS OF LANDSAT-4 THEMATIC MAPPER GEOMETRIC PROPERTIES*

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ABSTRACT

Landsat Thematic Mapper P-data of Washington, D. C., Harrisburg, PA, and Salton Sea, CA were analyzed to determine magnitudes and causes of error in the geometric conformity of the data to known earth-surface geometry. Several tests of data geometry were performed. Intra-band and inter-band correlation and registration were investigated, exclusive of map-based ground truth. Specifically, the magnitudes and statistical trends of pixel offsets between a single band's mirror scans (due to processing procedures) were computed, and the inter-band integrity of registration was analyzed. The line-to-line correlation analysis for single bands revealed the following: aside from two swath border areas where vaguely coherent patterns of offsets existed, there appeared to be no predictable, systematic offsets between scans in any of the scenes. In the Salton Sea scene, offsets of a given sample in a given set of adjacent near swath border scan lines (i.e., lines 41-45) were more often of the same sign (+/-) than of different signs, and the magnitudes of the offsets tended to be similar for that sample. The offsets varied between ±.5 pixels in 93% of the sample matches performed, and in the remaining 7%, the offsets generally were close to the ±.5 marks (within ±.8). The 93 percent figure was true in all scenes studied.

Intra-band misregistration of the P-tapes was not significant between bands of the primary focal plane (bands 1-4). In these, misregistration varied between ±.25 pixels 96% of the time, and most frequently was within the ±.15 pixel offset range. Between bands of the primary focal plane and bands of the secondary focal plane, pixel offsets were consistently negative and often in the range between -.75 and -1.25 pixels in the P-tape. A-tape inter-band misregistration was comparable to that of the P-tape in most respects. One notable exception was that bands 5 and 7 showed much improved registration between them in the P-tapes over the A-tapes.

*This abstract presents the results of one phase of research carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract no. NAS7-918, sponsored by the National Aeronautics and Space Administration.

A large number of control points were found by comparing 1:24,000 series topographic maps and the TM images. Least squares fits were performed between the pairs of point matrices (lat-long vs line-sample), and offset residuals were analyzed to determine the sources of the nonconformities on both individual and aggregated bases. In addition, the ground control points were tested for conformance to the Space Oblique Mercator (SOM) projection. The results of this particular test are pending. Scene to scene registration between Harrisburg images (40109 - 15134, 02NOV82 and 40189 - 15151, 21JAN83) show terrain offsets as predicted. There is also a projective geometry offset associated with using the SOM projection, which assumes a unique nominal nadir track for each scene.